LYCOMING

DIVISION - THE AVIATION CORPORATION

WILLIAMSPORT, 38, PENNA.

INVESTIGATION OF THE PERFORMANCE OF
THE 70727 REED VALVE COMBUSTION CHAMBER USING
THE 70862 FUEL SCREEN
Section I - Item 3 - Contract NOa(s)-4718

LYCOMING
DIVISION--THE AVIATION CORPORATION

REPORT NO. 1100

R E S T R I C T E D

Dates of Test:
February 25, 1947 and
March 5, 1947
Date of Report:
March 31, 1947

INVESTIGATION OF THE PERFORMANCE OF THE 70727 REED VALVE COMBUSTION CHAMBER USING THE 70862 FUEL SCREEN.

Section I - Item 3 - Contract NOa(s) 4718

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LYCOMING
DIVISION--THE AVIATION CORPORATION

REPORT NO. 1100

INVESTIGATION OF THE PERFORMANCE OF THE 70727 REED VALVE COMBUSTION CHAMBER USING THE 70862 FUEL SCREEN.

I N D E X

Index - Con't

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A P P E N D I X

Copies of log sheets, pages 135, 137, 145, 146 are attached to this report.

LYCOMING
DIVISION--THE AVIATION CORPORATION

REPORT NO. 1100

~~R E S T R I C T E D~~

INVESTIGATION OF THE PERFORMANCE OF THE 70727 REED VALVE COMBUSTION CHAMBER USING THE 70862 FUEL SCREEN.

OBJECT:

1. The object of this investigation was to determine the relative performance of the 70727 reed valve combustion chamber using the 70862 fuel screen.

SUMMARY:

2. The 70862 fuel screen is a steel cone with the surface perforated with holes. It was located in the front end of the chamber with the big end toward the rear.

3. The 70862 fuel screen was tested in an effort to improve the performance of the 70727 reed valve combustion chamber by promoting better atomization of fuel and mixing with the air.

4. The investigation was carried out with both the 1.060" diameter and the 1.375" diameter jet nozzle sizes.

5. While use of the 70862 fuel screen promoted steadier operation, no improvement in performance was found.

CONCLUSIONS:

6. It is concluded that:

(a) Operation with the 70862 fuel screen promotes consecutive cycles more nearly alike, than without the screen.

(b) No improvement in performance was found by use of the fuel screen.

an

(c) The performance with the fuel screen was slightly inferior to the "no screen" performance when using the 1.375" jet nozzle. The difference in performance with and without screen when using the 1.06" jet nozzle was negligible.

(d) Varying the injection nozzle tip distance from the front of the combustion chamber over a range of .75" to 1.75" did not affect performance.

RECOMMENDATIONS:

7. It is recommended that:

(a) Additional fuel screen and fuel injection nozzle design combinations be submitted for testing.

(b) Other methods of introduction of the air-fuel mixture into the combustion chamber be devised for testing.

DESCRIPTION:

8. Reference is made to Report No. 1097 entitled "Initial Test of the Multi Reed Valve Combustion Chamber", for a detailed description of the 70727 reed valve combustion chamber.

9. Print No. 70862 on page 12 shows the construction of the fuel screen. The sketch on page 5 shows the location of this screen in the combustion chamber.

10. A 60° spray angle Bosch injection nozzle was used.

METHOD OF TEST:

11. Using the 1.060" diameter jet nozzle, runs were made 900 cpm, 20 psi ram and about 95 lb/hr fuel flow. Both with and without the fuel screen, three injection nozzle tip distances from the front of

the chamber were tested over a range of .75" to 1.75". This distance (A) is shown on the sketch on page 5.

12. Using the 1.375" diameter jet nozzles, runs were made with and without the fuel screen at 900 cpm, 20 psi ram and three fuel flows from about 125 to 190 lb/hr. An injection nozzle tip location of 1.25" from the front of the chamber was used.

13. The report referred to in paragraph 8 and also Report No. 1056, entitled "Report on the Initial Test of the Rotary Sleeve Valve Combustion Chamber" describe the test stand and the equipment used in the subject tests.

RESULTS:

14. Results of the subject investigation are shown on the curves on pages 6 through 11. Data used is presented on prints of the original data sheets which will be found in the Appendix of this report. In addition, for the runs used, M.I.T. pressure-time indicator cards and photographs of the oscilloscope diagrams taken with the Trimount electronic pressure pick-ups are shown on pages 13 through 26.

15. The curve No. 7463, page 6 of thrust versus distance of the injection nozzle tip from the chamber end shows that with or without the use of the fuel screen, thrust remains practically constant over distances of .75" to 1.75" from the chamber end at a given set of operating conditions. This data was taken while using the 1.060" diameter jet nozzle.

16. Curves No. 7464 through 7468, pages 7 through 11 show comparative data taken on the 1.375" jet nozzle with and without the fuel screen. Over a range of fuel flows, operation without the fuel screen produced both higher thrust and higher specific thrust.

17. Referring to the M.I.T. pressure time indicator cards for run 751 on page 22 and run 754 on page 25 , which were taken respectively with and without the fuel screen at the same conditions, it can be seen that the card taken for run 751 has somewhat more scattered points than run 754 because of the unsteadier operation. This condition is more evident when observing the oscilloscope diagrams for runs Nos. 752 and 755 (Page 13) which were taken with and without the fuel screen.

DISCUSSION:

18. Tests of the 70862 fuel screens were restricted in scope since 60° was the widest spray angle obtainable with the fuel injection nozzles on hand. It is believed that this angle was too small to cause the fuel to impinge on the fuel screen when in use. To properly evaluate the performance with fuel impinging on the fuel screen in an attempt at better fuel atomization and mixture with the air, the fuel screen and the fuel injection nozzle designs should be selected in combination to ensure that fuel impingement on the screen occurs.

19. Judging by tests so far conducted investigation of other means of introduction of the air fuel mixture into the combustion chamber are imperative if any appreciable operational improvement is to be gained.

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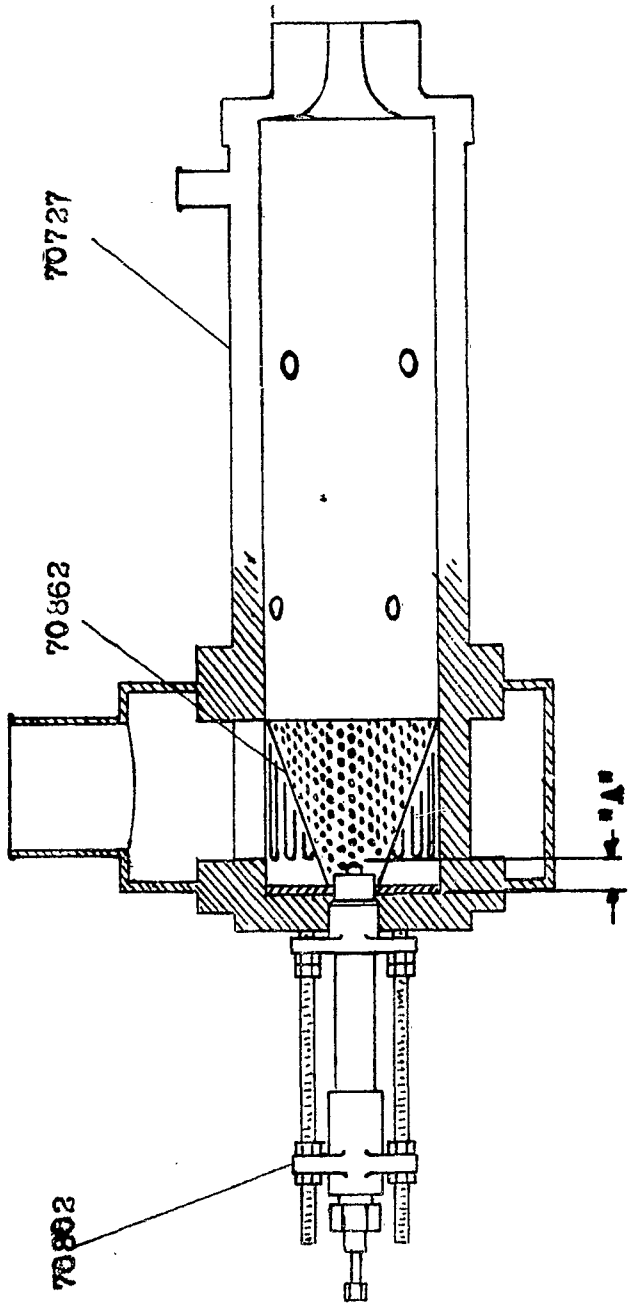
REPORT NO. 1100

Sketch of 70862 Fuel Screen Installed in the 70727 Reed Valve Combustion Chamber



LYCOMING
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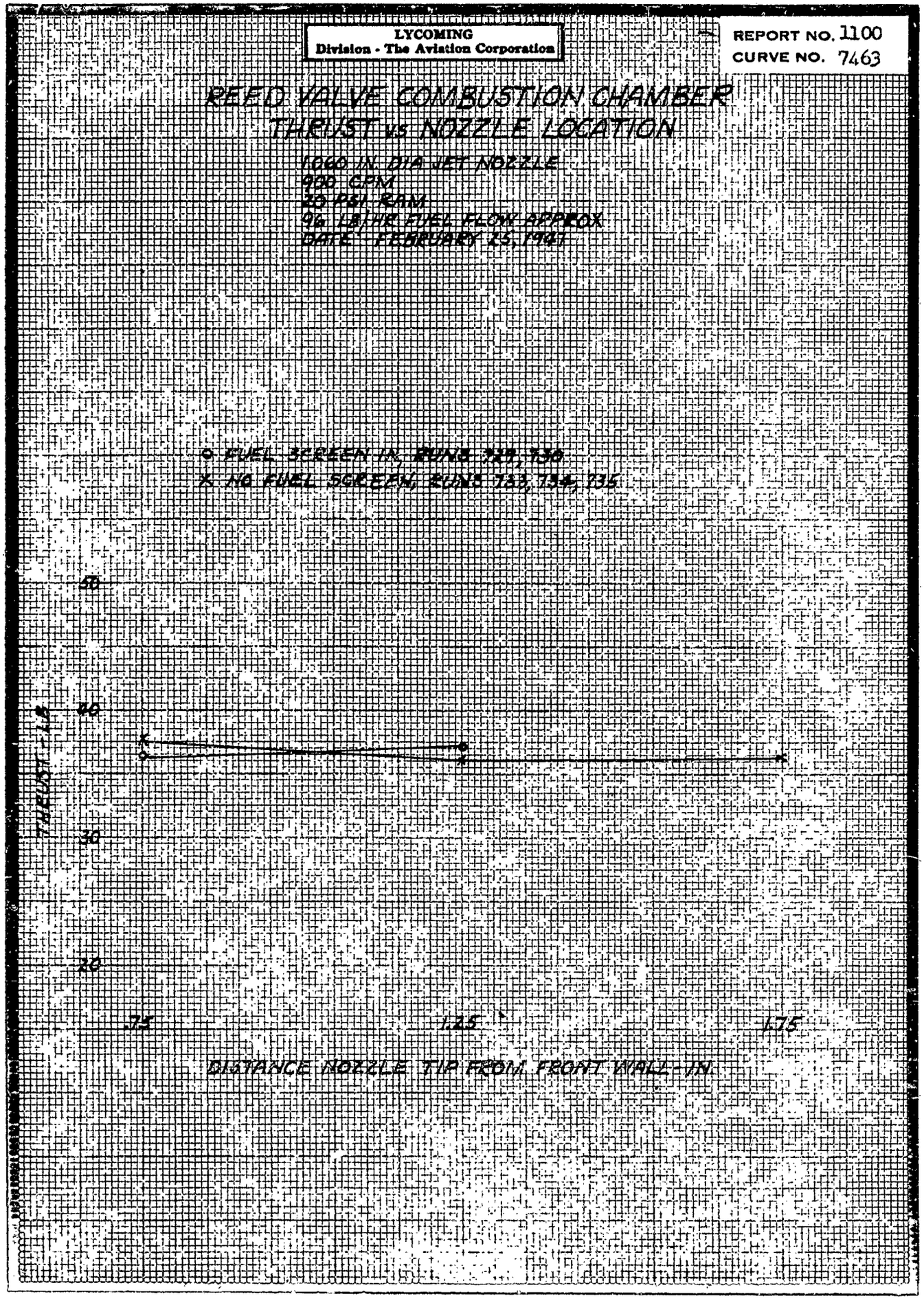
REPORT NO. 1100
CURVE NO. 7463

REED VALVE COMBUSTION CHAMBER
THRUST vs NOZZLE LOCATION

1060 IN. DIA JET NOZZLE
900 CPM
20 PSI RAM
96 LB/HR FUEL FLOW APPROX
DATE FEBRUARY 25, 1941



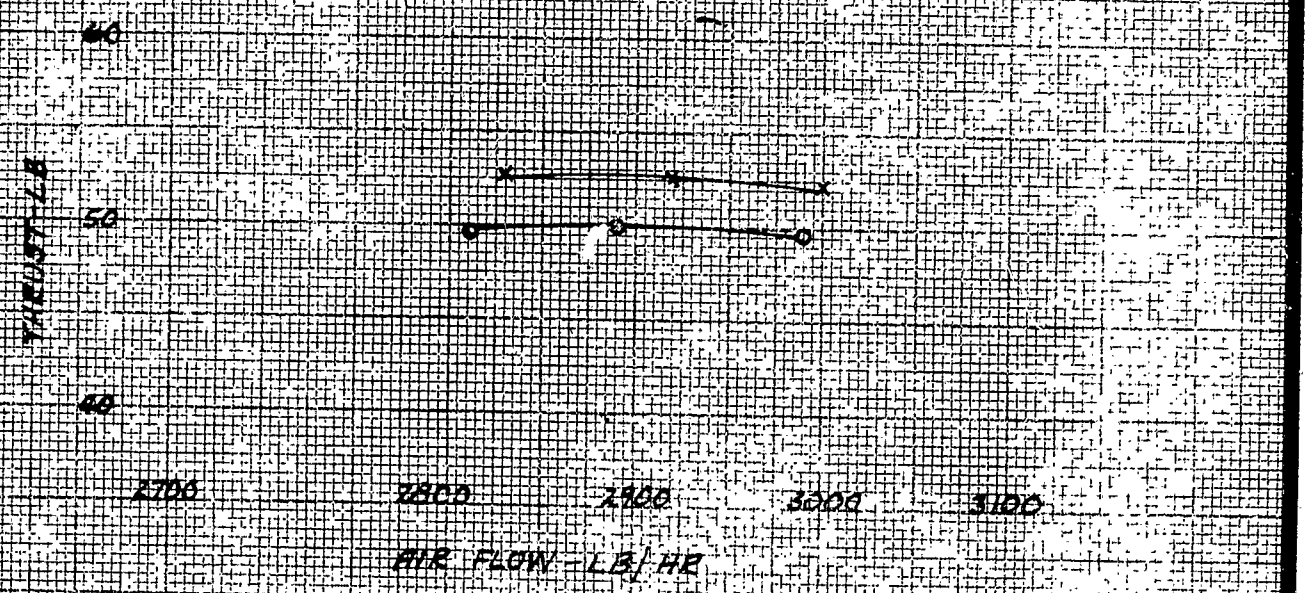
LYCOMING
Division - The Aviation Corporation

REPORT NO. 1100
CURVE NO. 7464

REED VALVE COMBUSTION CHAMBER
THRUST vs AIR FLOW

4.375 IN. DIA. JET NOZZLE
900 CPM
20 PSI RAM
DATE MARCH 5, 1947

⊙ FUEL SCREEN IN. RUNS 750, 751, 752.
× NO FUEL SCREEN. RUNS 753, 754, 755



LYCOMING
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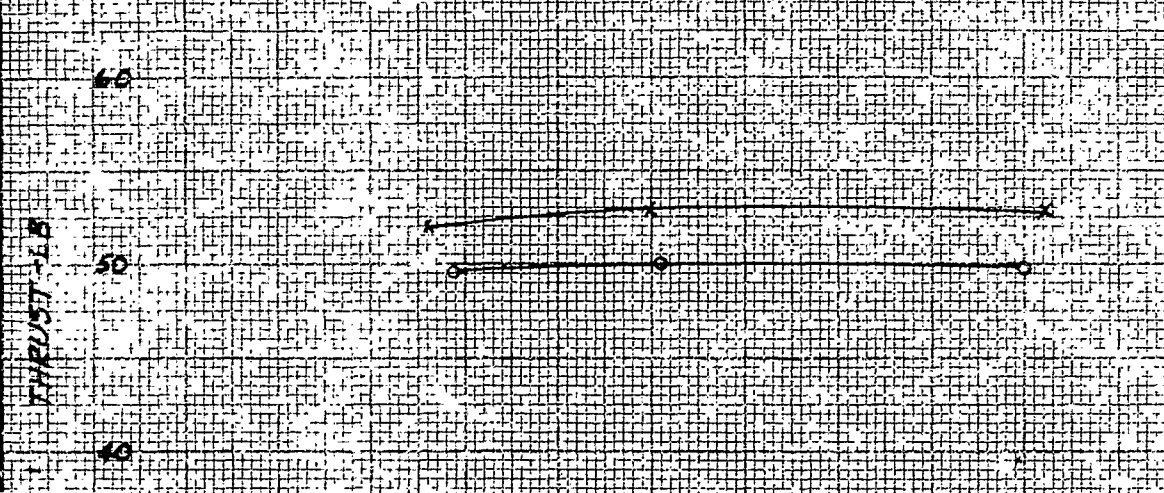
REPORT NO. 1100
CURVE NO. 7465

REED VALVE COMBUSTION CHAMBER
THRUST vs FUEL FLOW

1.375 IN. DIA JET NOZZLE
900 RPM
20 PSI RAM
DATE - MARCH 5, 1947

○ FUEL SCREEN IN. RUNS 750, 751, 752
× NO FUEL SCREEN. RUNS 753, 754, 755



100 110 120 130 140 150 160 170 180 190 200

FUEL FLOW - LB/HR

LYCOMING
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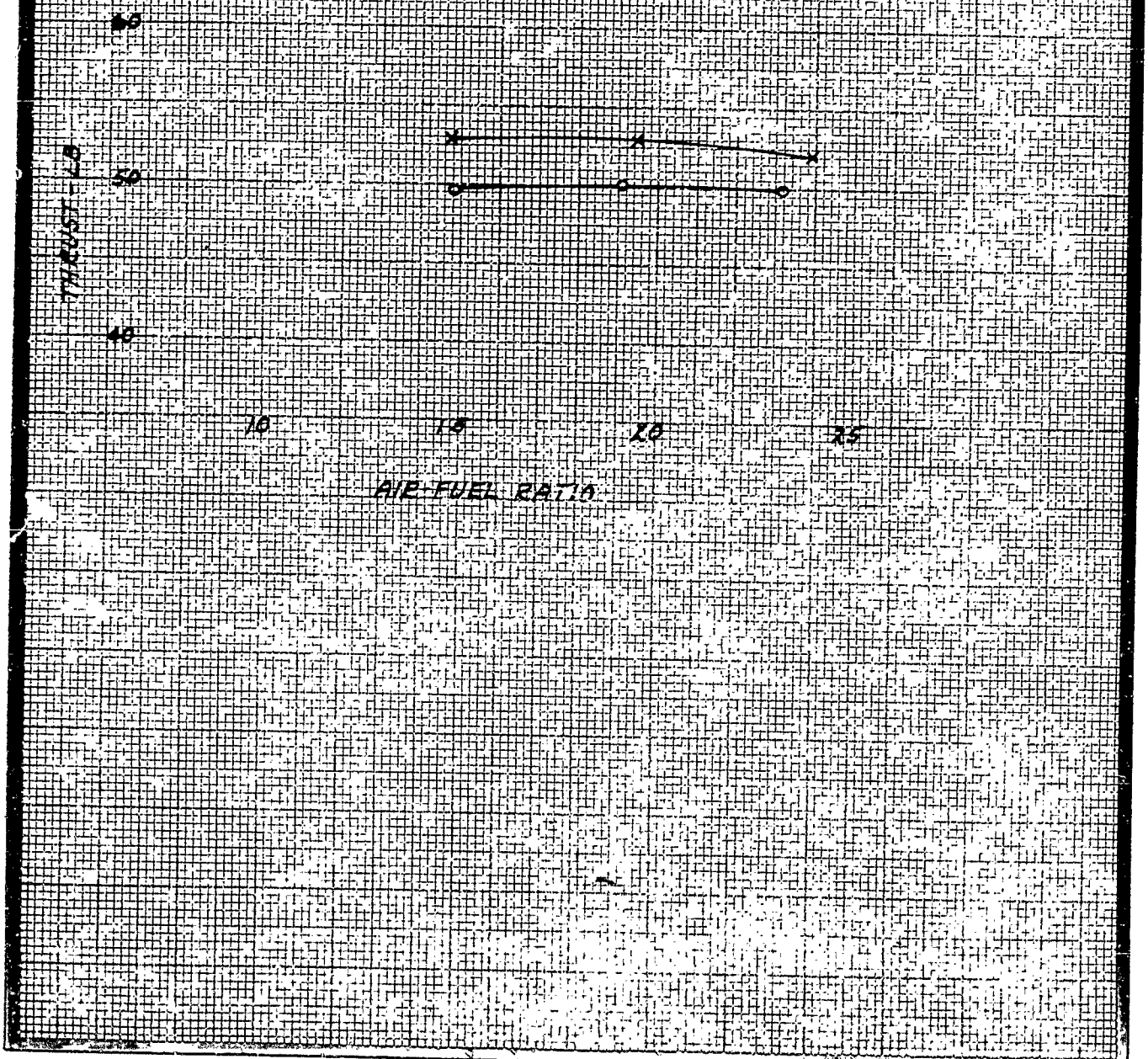
REPORT NO. 1100
CURVE NO. 7466

REED VALVE COMBUSTION CHAMBER
THRUST vs AIR FUEL RATIO

1.375 IN. DIA JET NOZZLE
900 CFM
20 PSI RAM
DATE MARCH 5, 1947

○ FUEL SCREEN IN. RUNS 750, 751, 752
× NO FUEL SCREEN RUNS 753, 754, 755



LYCOMING
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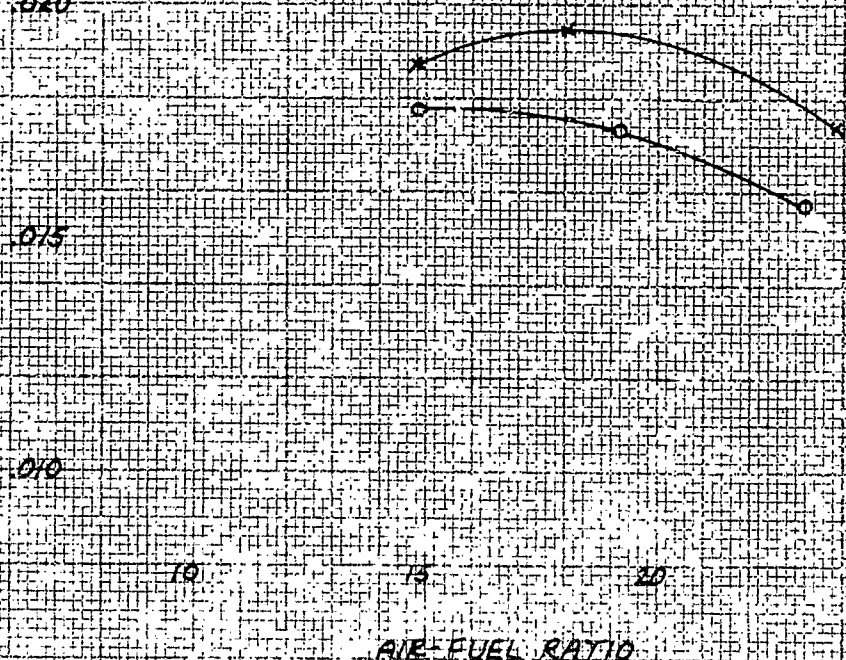
REPORT NO. 1100
CURVE NO. 7467

REED VALVE COMBUSTION CHAMBER
SPECIFIC THRUST vs AIR-FUEL RATIO

.375 IN. DIA JET NOZZLE
900 CPM
20 PSI RAM
DATE MARCH 5, 1947

○ FUEL SCREEN IN. RUNS 750, 751, 752
× NO FUEL SCREEN RUNS 753, 754, 755



LYCOMING
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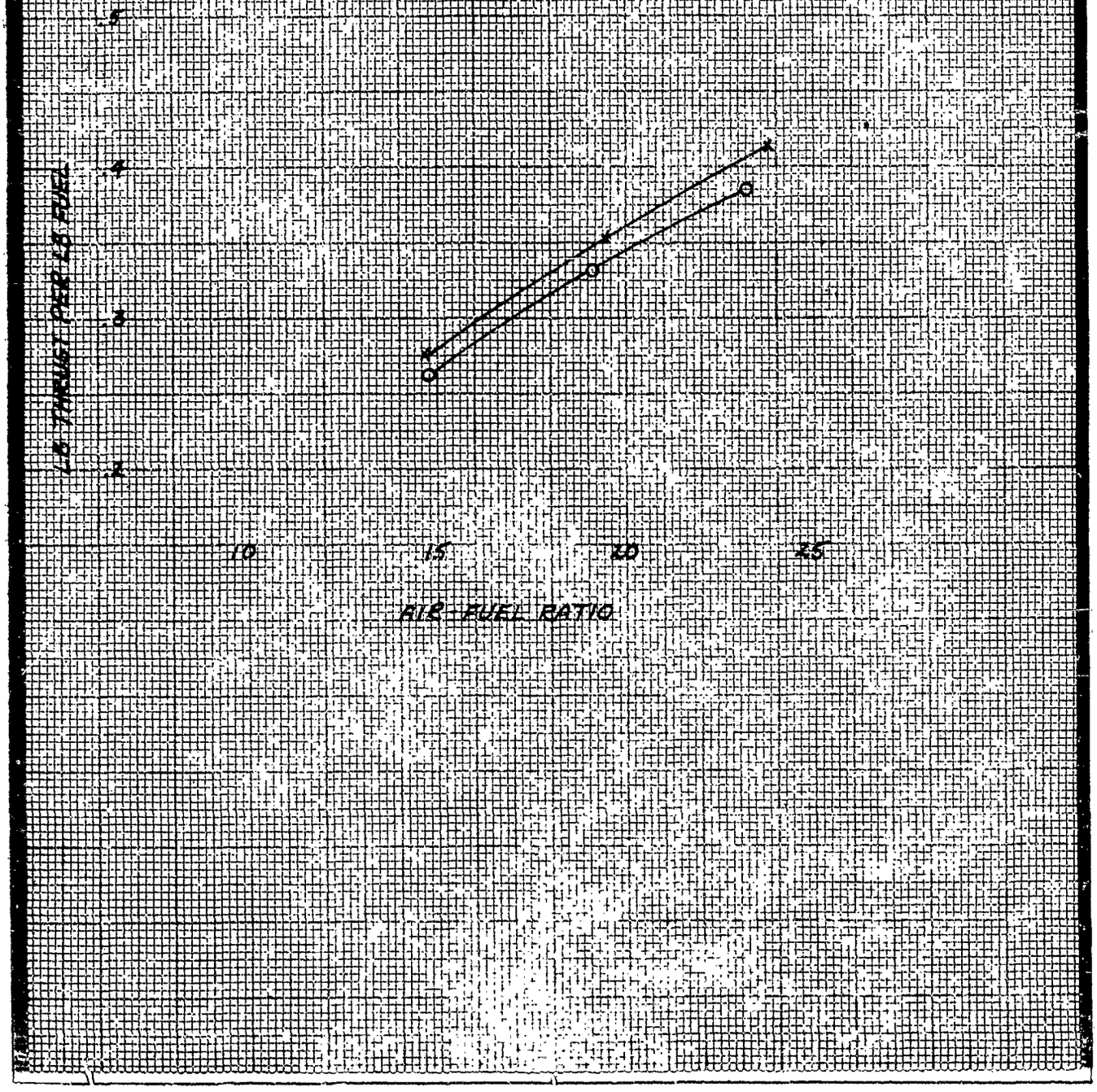
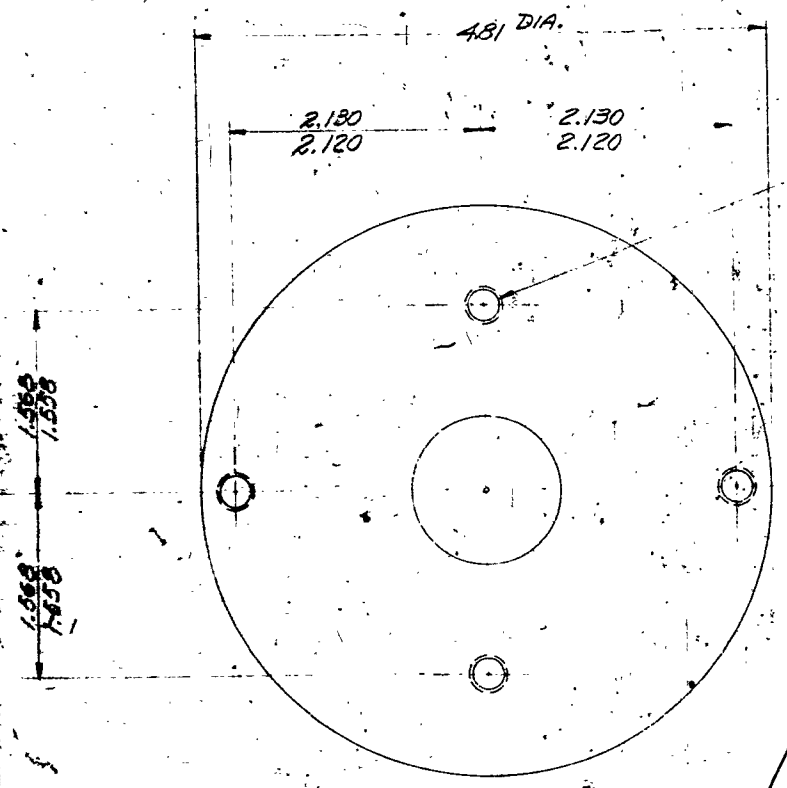
REPORT NO. 1100
CURVE NO. 7468.

REED VALVE COMBUSTION CHAMBER
SPECIFIC THRUST vs AIR-FUEL RATIO

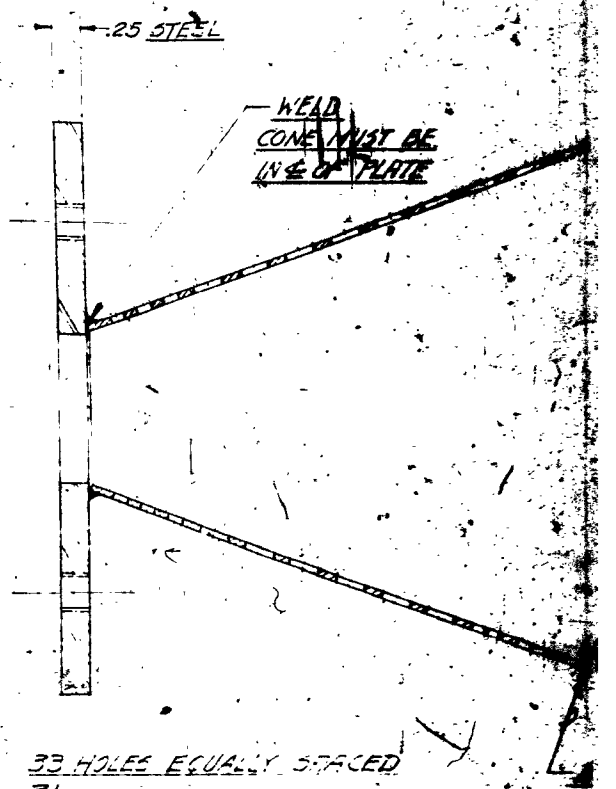
1.375 IN DIA JET NOZZLE
900 CPM
20 PSI RAM
DATE - MARCH 6, 1947

○ FUEL SCREEN IN. RUNS 750, 751, 752
× NO FUEL SCREEN. RUNS 753, 754, 755





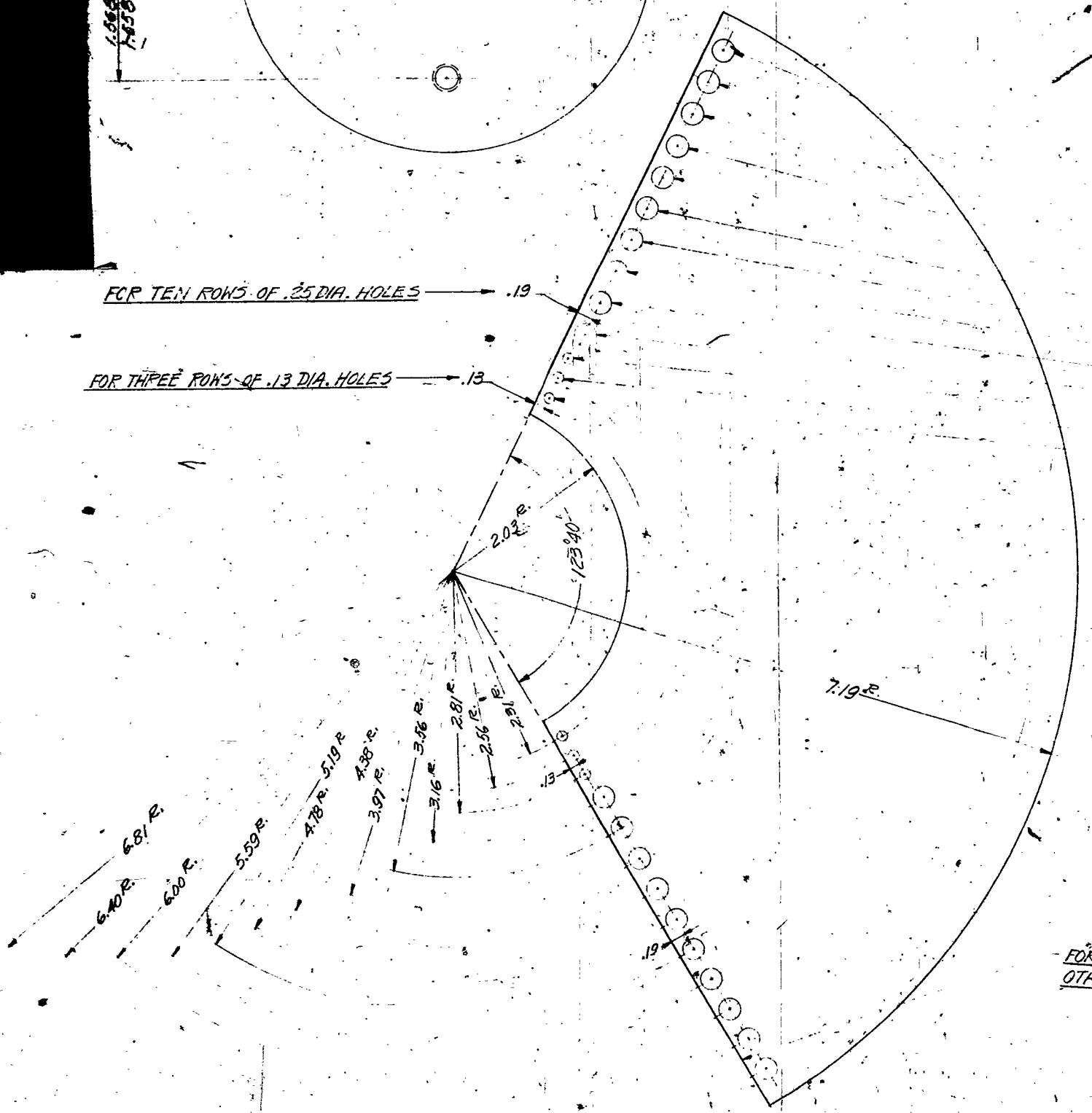
DRILL .2656
TAP .3125-24 N.F.3
P.D. - .2878 - .2954
4 HOLES



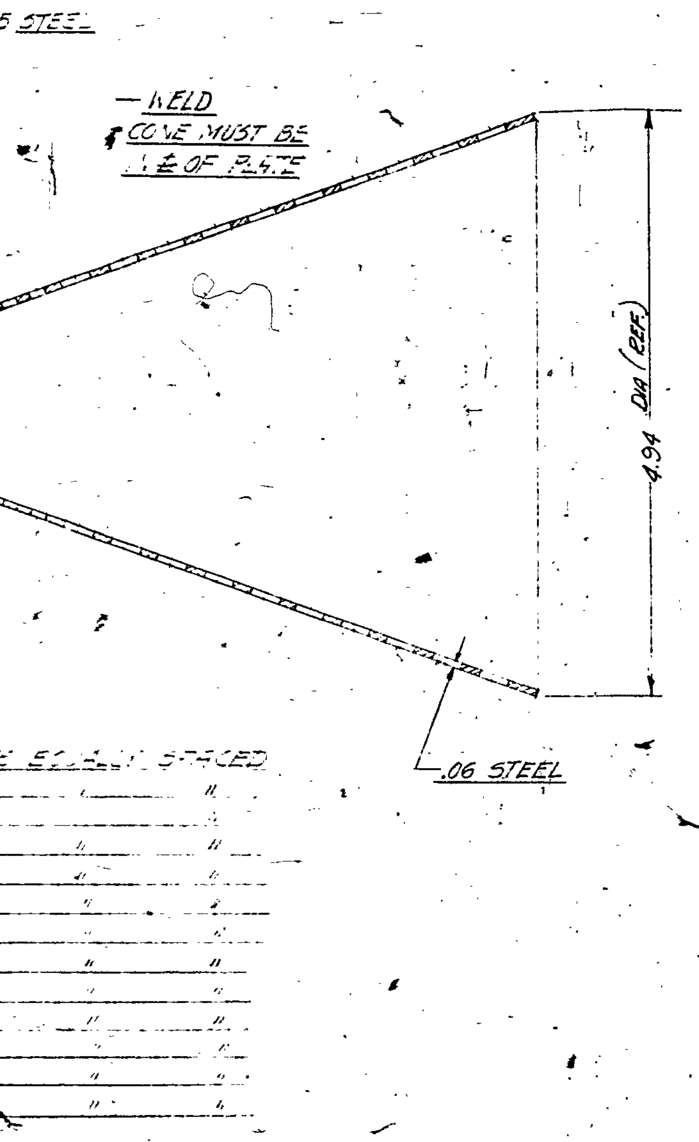
33 HOLES EQUALLY SPACED
31 " " "
29 " " "
27 " " "
25 " " "
23 " " "
21 " " "
19 " " "
17 " " "
15 " " "
20 " " "
20 " " "
20 " " "

FOR TEN ROWS OF .25 DIA. HOLES ——→ .19

FOR THREE ROWS OF .13 DIA. HOLES ——→ .13



FORM INTO CONE AND WELD TO OTHER SIDE WITHOUT OVERLAP



ALTERATIONS

DRAWN	ETG	8-16-46
TRACED		
CHECKED		
STRESS		
CF MET.		
CF DF		
PROJ ENG	ATG	8-21-46
PROD ENG		
CF ENG		

NEXT ASSEM | NO. REQ

70862

UNLESS OTHERWISE SPECIFIED
BREAK SHARP EDGES .005-.015 APPROXIMATE RADIUS
ALLOWABLE TOLERANCE ON ANGULAR DIMENSIONS ±2°
ALLOWABLE TOLERANCE ON FORGINGS IS +.06-.00
ALLOWABLE TOLERANCE ON CASTINGS IS ±.03
ALLOWABLE TOLERANCE ON FINISHED DIMENSIONS IS±.01

LYCOMING DIVISION—THE AVIATION CORP. WILLIAMSPORT, PA.

NOTES

MAG INSP | TREATMENT | FINISH

AS NOTED

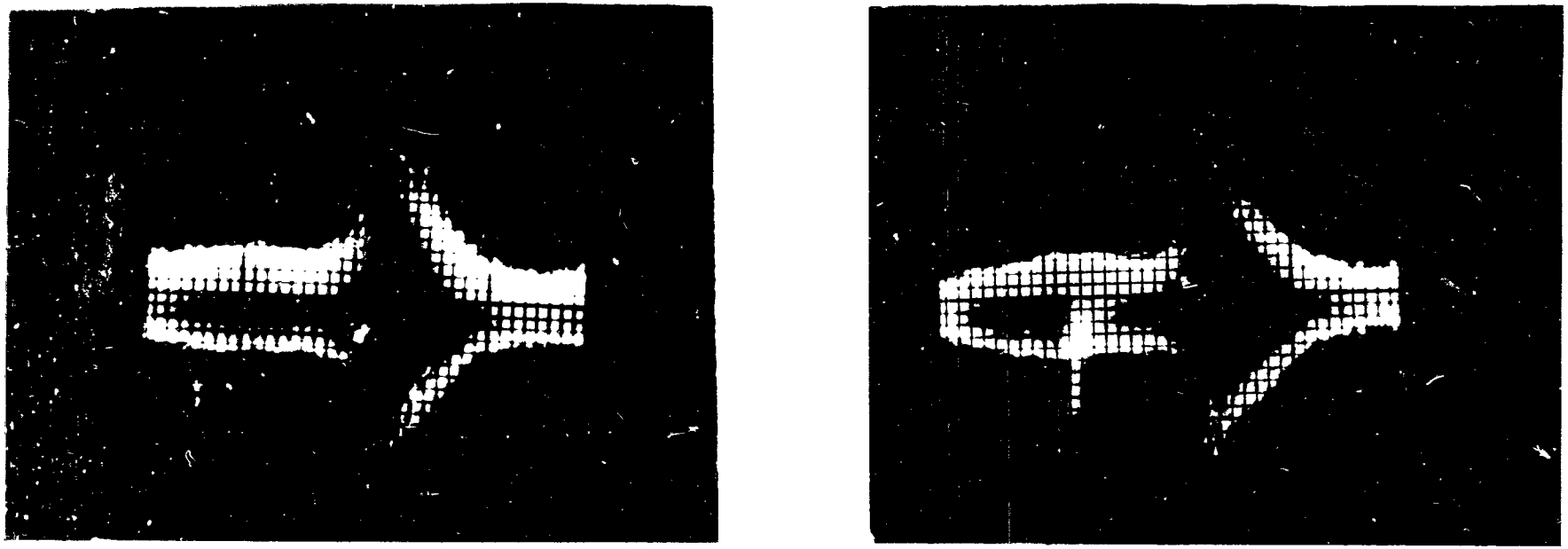
MAKE FROM | MATERIAL

SCREEN - FUEL

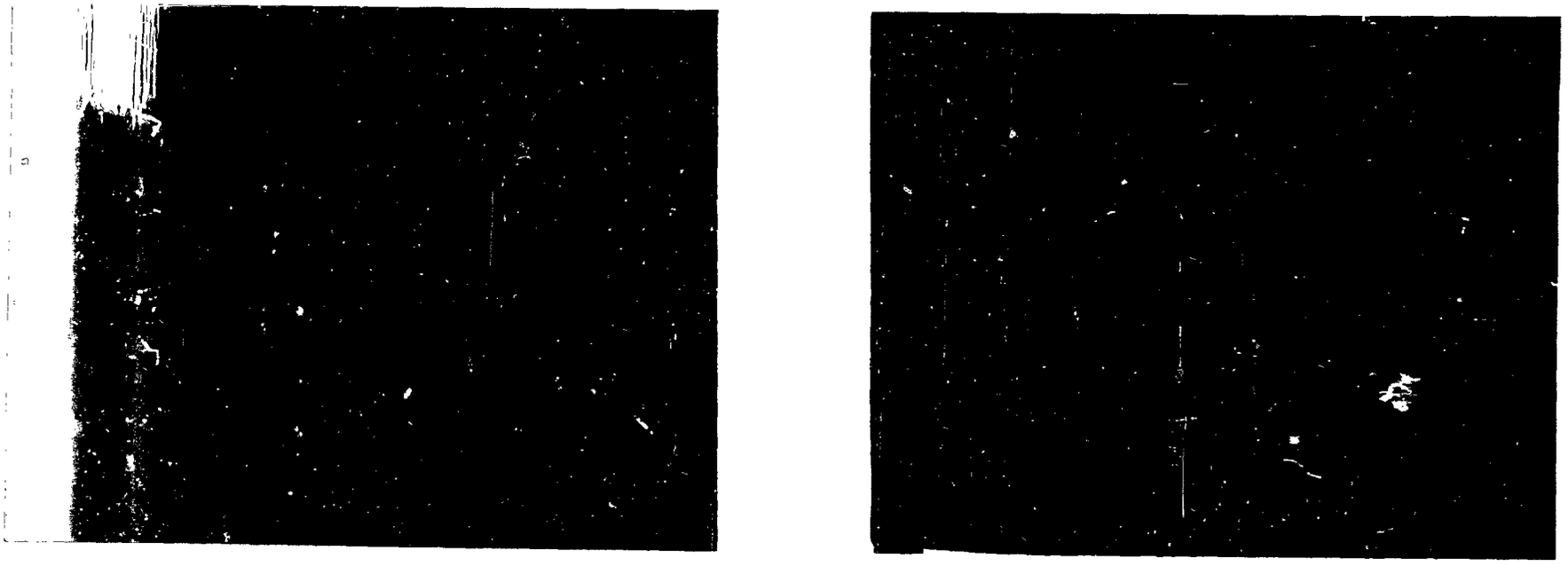
PART NAME

70862

DATE OF ISSUE



From Left to Right, Run Nos. 752 with Fuel Screen
and 755 without Fuel Screen. 1.375" Dia. Jet Nozzle.
900 CPM., 20 PSI Ram. March 5, 1947



From Left to Right, Run Nos. 729 and 730
Fuel Screen In. 1.060" Dia. Jet Nozzle.

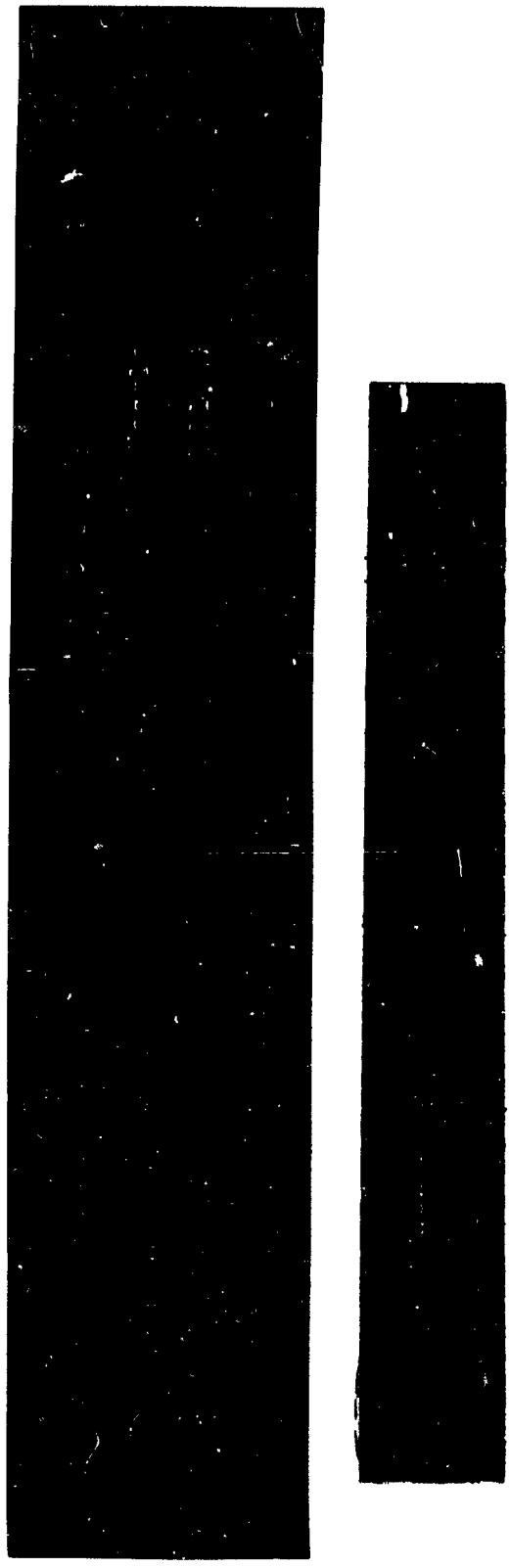
Fuel Injection Nozzle Tip .75 and 1.25 Inches
from Front Wall of Chamber.
900 CPM., 20 PSI Ram. February 25, 1947

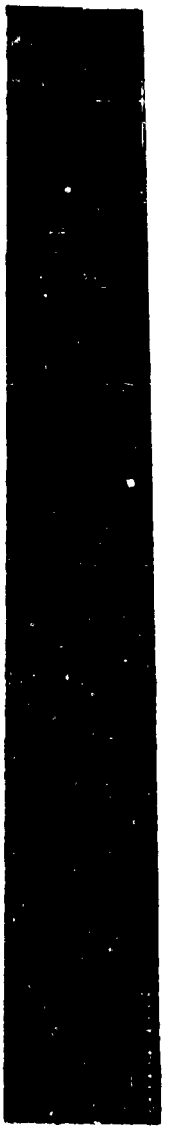
Above, from Left to Right, Run Nos. 733 and 734. To the Right, Run No. 735.

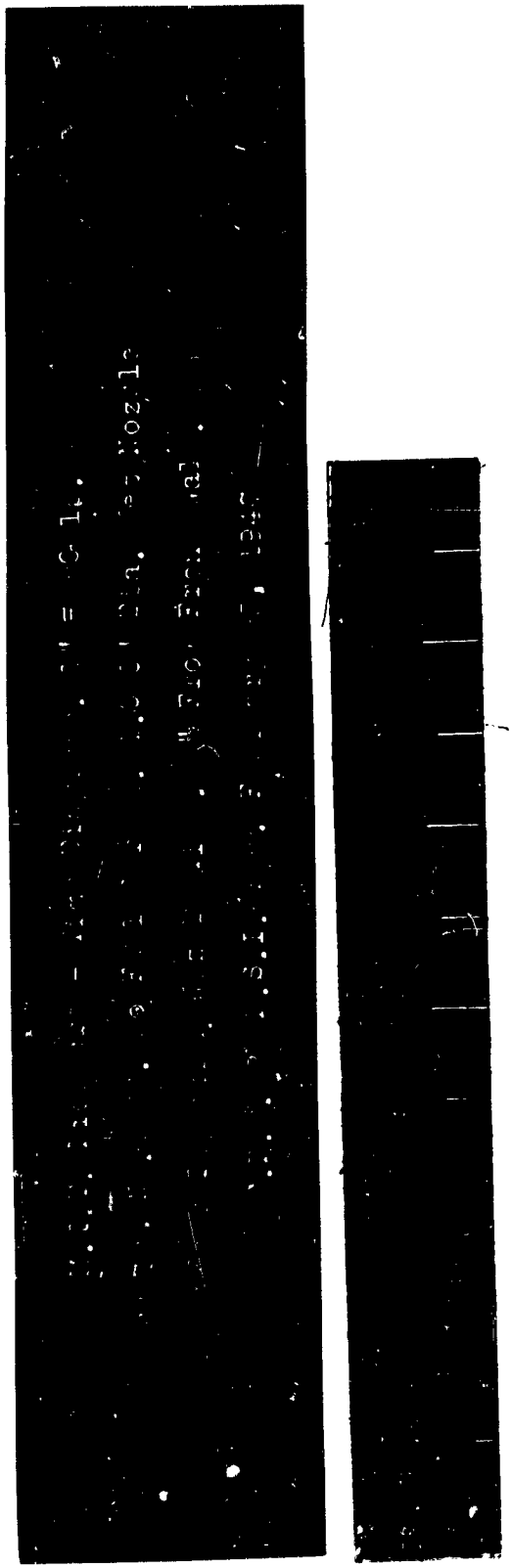
No Fuel Screen. 1.060" Dia. Jet Nozzle.

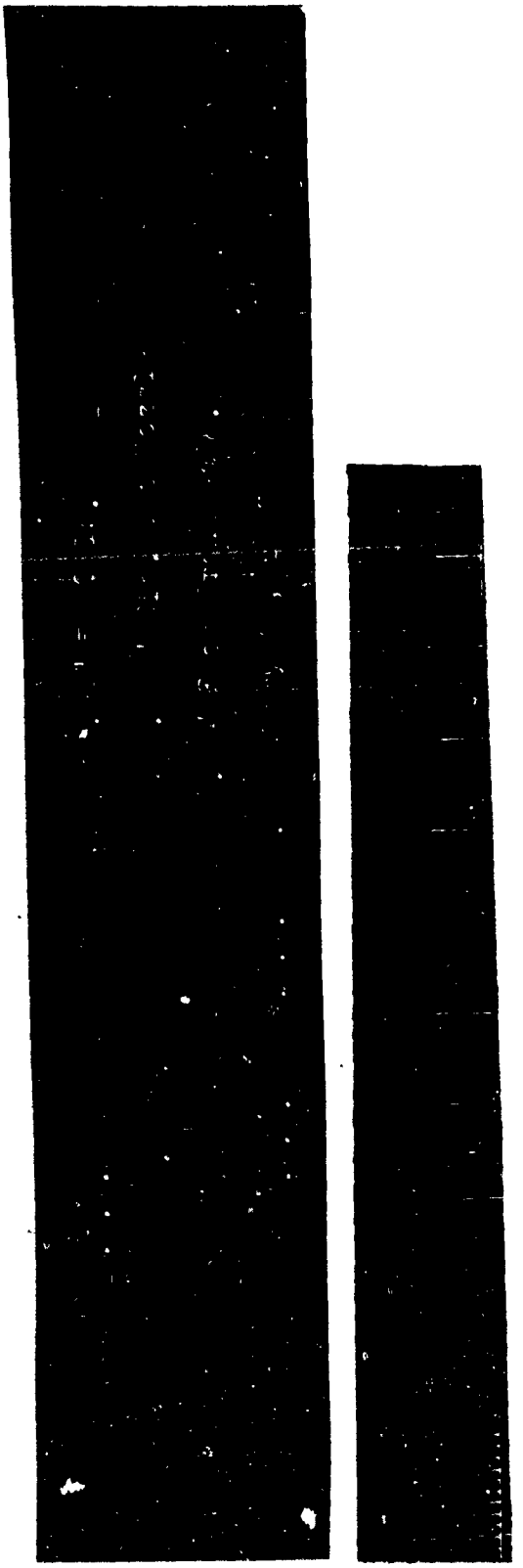
Fuel Injection Nozzle Tip .75, 1.25 and 1.75 Inches Respectively from Front Wall of Chamber.

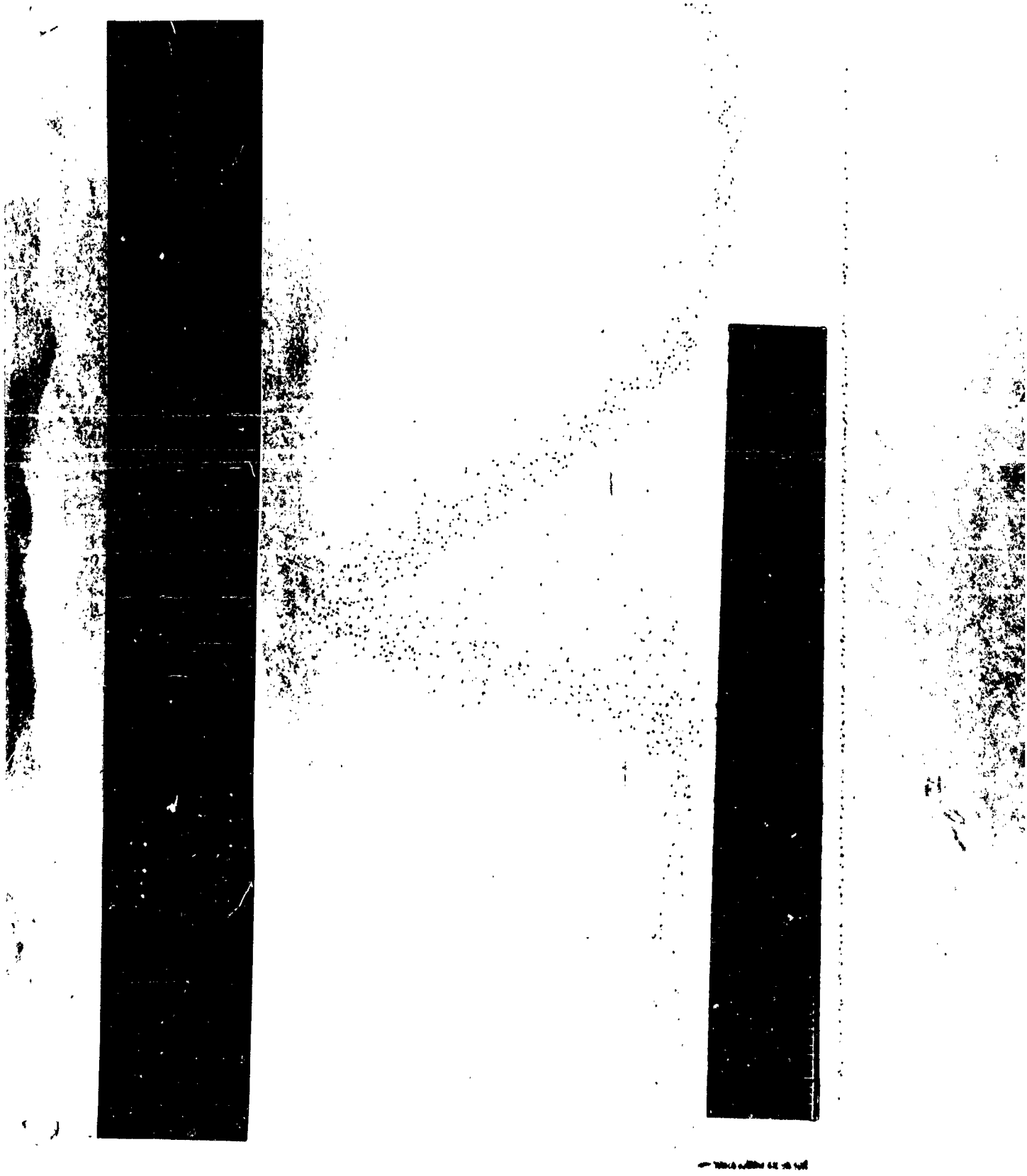
900 CPM, 20 PSI Ram
February 25, 1947

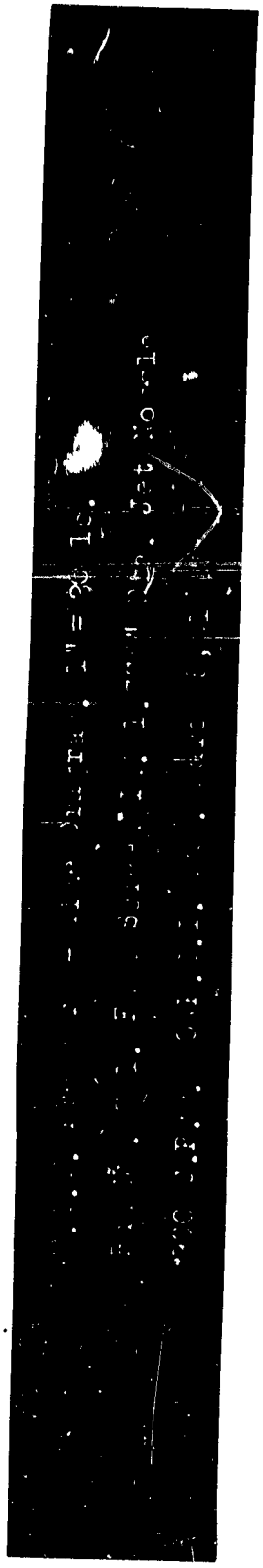


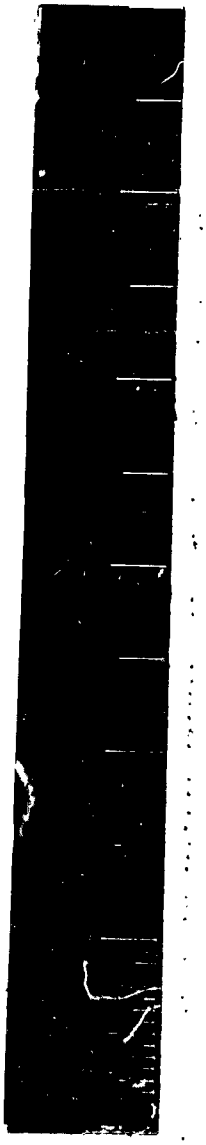


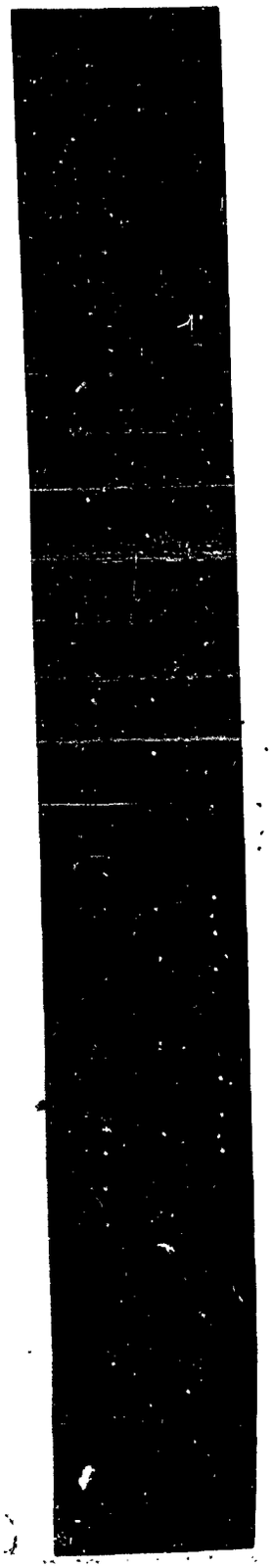


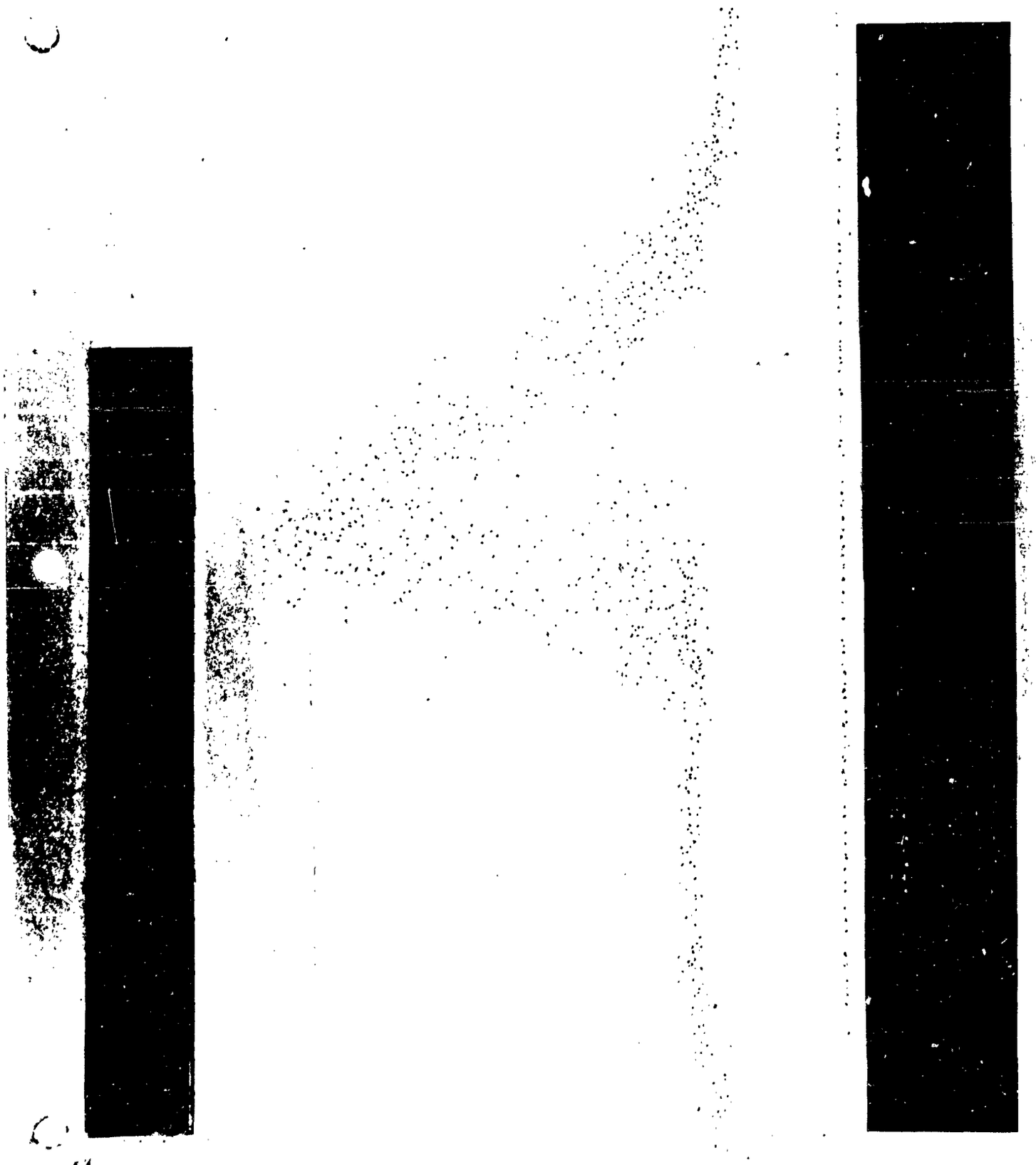












Test BASKET IN FRONT
TWO PLUGS IN FRONT
AND REAR SEATS, DIA
OFFSET ... 60° NOZZLE

LYCOMING
AERO [illegible]
[illegible] DATA
CONFIDENTIAL

Sheet No 135
Date 2-25-47

					FRONT	REAR	REAR	FRONT			FRONT
	RUN NO.		725	START	726	727	728	729	STOP	START	730
1	Time of Day		10:13	10:15	10:31	10:38	10:46	10:50	10:55	11:05	11:09
2	Cycle Speed	RPM			910	906	906	904			906
3	Ram Air Pressure	PSIG	20		20	20	20	20			20
4	Fuel Flow Meter				150	150	100	100			100
5	Fuel Time	Sec			72.96 1:12.96	74.21 1:14.21	[illegible] 1:51.43	111.58 1:51.58			108.85 1:49.55
6	Fuel Temp.	°F			41	40	39.5	40			42
7	Fuel Sp. Wt.	#/Gal			5.930	5.934	5.936	5.934			5.924
8	Fuel Sample	Gal			.5	.5	.5	.5			.5
9	Thrust Gauge Reading	PSI	40.9		52.9	52.8	50.0	50.6			50.1
10	Thrust Meter Reading										
11	Ind. Thrust Hyd	Lb	23.0		40.5	40.4	36.4	37.1			36.4
12	Ind. Thrust Electronic	Lb									
13	Cyl Press -Gauge Reading	PSIG	18.7		30.4	30.8	27.0	28.0			27.8
14	Cyl Press Meter Reading	100#			32.4	33.0	29.0	30.6			29.5
15	Ind Cyl Press -Electronic	PSIG			35	35.3	31.1	33			32
16	Comb Airflow P_1	PSI	76		76.1	76.0	76.1	76.0			76.0
17	Comb Airflow P_1	"Hg A.	183.7		183.9	183.7	183.9	183.7			183.7
18	Comb Airflow ΔP	"H2O	12.9		5.9	5.1	5.5	6.9			7.0
19	Comb Airflow T_1	°F	62		108	117	123	128			148
20	Comb Airflow T_1	°R	522		568	577	583	588			608
21	Airflow	Lb/Hr	2467		1613	1487	1537	1714			1692
22	Cooling Water Press	"H2O	19.9		29.[illegible]	27.5	26.6	26.1			17.5
23	Cooling Water T. In	°F	57		47	48	48.5	49			49.5
24	Cooling Water T. Out	°F	46		[illegible]	120	107	115			122
25	~~Oil Press~~ #/HR/# FUEL	~~PSI~~			.2765	.281					.374
26	~~Uni-Scale~~ #/HR/# AIR	~~Lb~~			.0251	.0272					.0215
	COMB CHAMB TEMP	°F			1410	1130	940	1180			1050
	RAM AIR TEMP	°F	45		78	84	91	96			121
	" " "	°R	505		538	544	551	556			551
	FUEL FLOW (DISC METER)	#/HR			146.5	144.0	95.8	95.7			97.4
	AIR FUEL RATIO				11.0	10.31	16.07	17.91			17.38

BACKED OUT NOZZLE 1/2 (About FULLY RETRACTED)

No BASKET

TWO PLUGS IN FRONT & REAR BLEED PIA. OPPOSITE 60° NOZZLES

MOUNTING PLATE
CONFIDENTIAL

Sheet No 157
Date 2-25-47

			732	START	733 FRONT	STOP	START	734 FRONT	STOP	START	735
1	Time of Day	HR	11:50	11:55	2:04	2:30	2:34	2:41	2:46	2:50	2:59
2	Speed Bored	RPM			901			885			906
3	Inlet Air Pressure	PSIG	20		20			20			20
4	Fuel Flow Meter	#/HR			100			100			100
5	Fuel Time	SEC			1:18.03			1:16.16			1:51.30
6	Fuel Temp	°F			48			41.5			41.5
7	Fuel Specific Gr	#/G			5804			5.928			5.928
8	Fuel Samples	Gal			5			.5			.5
9	Thrust Gauge Reading	PSI	40.3		50.9			50.0			50.1
10	Thrust Meter Reading										
11	Ind Thrust Hyd	Lb	22.0		37.6			36.2			36.3
12	Ind Thrust Electronic	Lb									
13	Cyl Press Gauge Read R	PSIG	18.75		28.4			27.7			27.7
14	Cyl Press Meter Read R	100			31.8			30.7			30.4
15	Ind Cyl Press Calculated	PSIG			34			33			32.9
16	Comb Inlet Pr P1	PSI	75.6		76.1			76.0			76.0
17	Comb Inlet Pr P1	"Hg Abs	182.7		183.9			183.7			183.2
18	Comb Inlet Pr dP	"H2O	13.2		6.6			7.0			7.0
19	Comb Inlet Temp T1	°F	67		103			135			142
20	Comb Inlet Temp T1	°R	527		563			595			602
21	Air Flow	Lb/	7528		1714			1713			1710
22	Inlet Water Press	"H2O	24		31.1			35.2			31.3
23	Coolant Water T In	°F	51.5		46.5			44			50
24	Coolant Water T Out	°F	49.0		119.5			111.5			114.5
25	Oil Press	PSI									
26	Oil Scale	Lb									
	COMB CHAMB TEMP	°F			1400			1320			1340
	RAM AIR TEMP	°F	50		74			108			114
	" " "	°R	510		534			568			574
	FUEL FLOW (Per Hour)				96.5			91.8			95.8
	AIR FUEL RATIO				17.75			18.65			17.85

GEE BEE 28.92

* REAR PLUG LOCATION UNSATISFACTORY - WOULD CONSIDER AND SUGGEST FOR THRUST MEASUREMENTS.

FUEL BASKET IN
1 7/8" DIA JET NOZZLE
60° INJ NOZZLE 1/2 IN
FROM FULLY RETRACTED

LAUNCHING
AERO PULSE
OBSERVED DATA
CONFIDENTIAL

Sheet No 165
Date 3-5-47

	Run No.		747	Start	748 BOTH	749 REAR	Stop	Start	Stop	Start	750 *FRONT
1	Time of Day	Hr Min	10:47	10:45	11:02	11:15	11:30	1:15	1:30	2:43	2:53
2	Cycling Speed	IPM			896	895					895
3	Ram Air Pressure	PSIG	20		20	20					20
4	Fuel Flow Meter	#/Hr			100	100					130
5	Fuel Time	Min Sec			109.29 1:49.29	107.35 1:47.35					83.55 1:23.55
6	Fuel Temp	°F			43	41.5					47.5
7	Fuel Sp Wt.	#/Gal			5.924	5.929					5.906
8	Fuel Sample	Gal			.5	.5					.5
9	Thrust Gauge Reading	PSI	51		56.7	54.6					59.2
10	Thrust Meter Reading										
11	Ind Thrust Hyd	Lb.	37.7		46	43					49.6
12	Ind Thrust Electronic	Lb.									
13	Cyl Press -Gauge Read'g.	PSIG	18.2		20.9	19.8					21.4
14	Cyl Press Meter Read'g				21.7	20.0					21.2
15	Ind Cyl Press -Electronic	PSIG			25	23.1					27.4
16	Comb Airflow P_1	PSI	76.1		76.7	77.1					76.2
17	Comb Airflow P_1	"Hg Abs	184.19		185.29	186.19					184.29
18	Comb Airflow ΔP	"H2O	36.1		21.6	19.3					21.1
19	Comb Airflow T_1	°F	89		137	144					130
20	Comb Airflow T_1	°R	549		597	604					590
21	Airflow	Lb/Hr	4070		3025	2854					2990
22	Cooling Water Press	"H2O	19.3		47.5	36.0					19.2
23	Cooling Water T In	°F	50		48	49					48
24	Cooling Water T Out	°F	51		77	78					60
25	~~[illegible]~~ #THRUST/#FUEL	PSI			.471	.432					.385
26	~~[illegible]~~ #THRUST/#AIR	Lb			.0152	.01507					.01568
	COMB CHAMB TEMP	°F			860	—					1030
	RAM AIR TEMP	°F	71		113	120					105
	" " "	°R									
	FUEL FLOW (DISP METER)	#/HR			97.7	99.4					126.6
	AIR-FUEL RATIO				31.0	28.7					23.2
	MAN PRESS (MEAN)	50#			34.5	35.5					36.0
	" " "	PSIG			18.2	18.7					19.

(Written vertically in Stop/Start columns:) ONE SPARK PLUG ON EACH END NOT FIRING. REPLACED ALL SPARK PLUGS WITH NEW ONES. — GUN STILL MISFIRING SPARK TO CHECK PLUGS. CLEANED BOTH FRONT PLUG. REVERSE FLOW. — CHECK OK. — OPERATING UNSTEADY ON ONE OR BOTH PLUGS. BELOW 130 #/HR FUEL.

CORR BAR 29.19
* REAR PLUGS GAVE ABOUT 2 # LESS THRUST, SOME LESS MEAN PRESS.

TEST FUEL BASKET IN,
1 3/8" DIA JET NOZZLE
60° INJ NOZZLE 1/2 IN
FROM FULLY RETRACTED

LYCOMING
AERO PULSE
[illegible] DATE
CONFIDENTIAL

Sheet No 146
Date 3-5-47

			FRONT	FRONT				FRONT	FRONT	FRONT	
	RUN NO.		757	752*		STOP	START	753	754	755	STOP
1	Time of Day	Hr Min	3:07	3:16		3:31	3:50	3:52	4:04	4:10	4:20
2	Cyclic Speed	IPM	896	902				910	895	905	
3	Ram Air Pressure	PSIG	20	20			20	20	20	20	
4	Fuel Flow Meter	#/Hr	155	195				130	156	195	
5	Fuel Time	Min Sec	70.86 1:10.86	112.86 1:52.56				84.56 1:24.56	69.0 1:9.00	55.4? 0:55.4?	
6	Fuel Temp.	°F	41	40				43	41	39.5	
7	Fuel Sp Wt	#/Gal	5.930	5.934				5.924	5.930	5.936	
8	Fuel Sample	Gal	.5	1.0				.5	.5	.5	
9	Thrust Gauge Reading	PSI	59.4	59.0				60.5	61.0	61.0	
10	Thrust Meter Reading										
11	Ind. Thrust Hyd	Lb	50	49.6				52	52.7	52.7	
12	Ind Thrust Electronic	Lb									
13	Cyl Press -Gauge Read'g	PSIG	21.8	22.0				21.8	21.8	22.2	
14	Cyl. Press Meter Read'g	100	25	24.8				24.5	24.3	24.0	
15	Ind. Cyl. Press -Electronic	PSIG	29	28.7				28	28	24.2	
16	Comb Airflow P_1	PS	[illegible]	184.99				184.19	184.19	184.99	
17	Comb Airflow P_1	"Hg Abs	76.5	76.5				76.0	76.1	76.5	
18	Comb Airflow ΔP	"H_2O	20.3	19.4				21.2	20.5	19.4	
19	Comb Airflow T_1	°F	153	158				130	147	152	
20	Comb Airflow T_1	°R	613	618				590	607	612	
21	Airflow	Lb/Hr	2890	2810				3000	2920	2830	
22	Cooling Water Press	"H_2O	14.5	14.0				16.6	17.0	17.0	
23	Cooling Water T In	°F	48	48.6				50	50	50	
24	Cooling Water T Out	°F	113	110.5				108	109	107.5	
25	~~Oil Press~~ # THRUST / # FUEL	PSI	.332	.261				.413	.351	.274	
26	~~Oil Temp~~ # THRUST / # AIR	Lb.	.0173	.01765				.01732	.018	.0186	
	COMB CHAMB TEMP	°F	1030?	940?				1060	1090	1060	
	RAM AIR TEMP	°F	130	135				108	122	130	
	" " "	°R	590	595				568	582	590	
	FUEL FLOW (DISP METER)	#/Hr	150.7	190				126	150	192.2	
	AIR FUEL RATIO		19.16	14.8				23.8	19.45	14.72	
	MAN PRESS (MEAN)	50#	35.8	36.8				36.9	35.7	35.5	
	" " "	PSIG	18.8	19.2				19.0	18.8	18.7	

* REAR PLUGS BETTER - 61 # THRUST, BUT OPERATION VERY UNSTEADY